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# Developing dimensions and key indicators for the safety climate within China's construction teams: A questionnaire survey on construction sites in Nanjing

Qiming Li [a,1], Chuang Ji [a,*], Jingfeng Yuan [a,2], Ranran Han [b,3]

[a] Department of Construction and Real Estate, Southeast University, Nanjing 210096, PR China
[b] Department of Cost Control, Agile Property Holdings Limited, Nanjing 210022, PR China

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ABSTRACT

The safety climate of construction teams has become increasingly important in the processes of construction safety management because of the significantly high rate of casualties in construction teams. This study examined safety climate dimensions (SCDs) and identified critical safety climate indicators (SCIs) at the level of the construction team from three perspectives: construction team workers, the safety environment, and safety management and supervision. Based on the survey data gathered from the construction team workers in Nanjing, China, a confirmatory factor analysis was carried out. As a result, six SCDs (*workers' self-perception of safety, workers' involvement in safety, co-workers' interaction, safety environment, safety management involvement, and safety personnel support*) were significantly important to the safety climate of the construction teams. An improved model was then developed. Furthermore, the effects of SCIs on SCDs as well as SCDs and SCIs on the safety climate were evaluated and discussed. The results showed that (a) *safety management involvement* and *safety personnel support* significantly influenced the safety climate of construction teams more than the other dimensions; (b) *working pressure* would be more helpful than *workers' safety awareness* and *mentality* for improving the *workers' self-perception of safety*; and (c) *safety procedure and policy* was the most important indicator of the safety climate among all twenty SCIs for construction teams in China. These findings might be helpful for improving the measurement and management of the safety climate within construction teams.


## 1. Introduction

It is generally acknowledged that the construction industry is one of the most injury/accident-prone industries (Feng et al., 2014; Kines et al., 2010; Seo et al., 2015; Sunindijo and Zou, 2012). The Ministry of Housing and Urban-Rural Development in China (2015) reported that China's construction industry suffered 482, 527 and 519 safety accidents (i.e., falling injury, collapse, mechanical injury, object strike, electric shock) among construction workers per year from 2012 to 2014 and a total of 1932 fatalities during these three years. Similar to other countries, the construction industry continues to be one of the most hazardous industries in China at present. Therefore, it is necessary to further improve the safety of the workforce at construction sites (Feng et al., 2014; Li et al., 2015; Liao et al., 2015; Liu et al., 2015; Zhou et al., 2008). Scholars have put forth great effort, yielding many research results, in studying construction safety, focusing on topics including safety competency, accident statistics, design for safety, safety culture, safety performance, safety behavior, safety climate, etc. at the organizational levels of industry, company, project, sub-project, task/activity, team and individual (Feng, 2013; Kapp, 2012; Lai et al., 2011; Shen et al., 2015b; Zhou et al., 2015).

The trend of construction safety research is much more diversified (Zhou et al., 2015). The safety climate has always been highly studied by construction safety researchers. The safety climate was conceptualized as organizational members', workers' or employees' shared perceptions about their working environments, working practices, organizational safety policies, and management

* Corresponding author at: Room 1308, Yi Fu Hall, No. 2 Sipailou of Xuanwu District, Nanjing, PR China.
*E-mail addresses:* njlqming@163.com (Q. Li), ji.chuang@hotmail.com (C. Ji), 101011337@seu.edu.cn (J. Yuan), hanranran@agile.com.cn (R. Han).
[1] Present address: Room 1302, Yi Fu Hall, No. 2 Sipailou of Xuanwu District, Nanjing, PR China.
[2] Present address: Room 1311, Yi Fu Hall, No. 2 Sipailou of Xuanwu District, Nanjing, PR China.
[3] Present address: No. 33 South Longpan Road of Qinhuai District, Nanjing, PR China.

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related to safety in the organization (Niskanen, 1994a; Smith et al., 2006; Yule, 2003; Zohar, 1980). It is related to safety behavior and unintentional injuries (Liu et al., 2015), which is normally considered to be one predictor of the safety performance of a company, work place or team (Griffin and Neal, 2000; Zou and Sunindijo, 2013). The safety climate has also been referred to as a snapshot or antecedent of the organization safety (Choudhry et al., 2007; Cigularov et al., 2010; Flin et al., 2000). Therefore, the influence of the safety climate has attracted more and more attention about the development of safety studies and practices in the construction industry (Cigularov et al., 2010; Shen et al., 2015b; Zhou et al., 2008).

However, most prior studies on the safety climate in the construction industry concentrated on the industry, company, project, and group levels (Zhou et al., 2015), and only a limited number of studies were conducted on the construction team level (Lingard et al., 2010). As a primary-level organization of a construction enterprise at the construction site, the construction team is responsible for almost all of the construction tasks, which are related to the specific behavior of the workers, the material, the construction method, the equipment/tools, and the working environment. Frontline workers within construction teams are more likely to be influenced by daily tasks and interactions with team members (Lingard et al., 2010). Consequently, they are the primary victims of construction accidents (Haslam et al., 2005). The team-level safety climate is a stronger predictor of the safety performance than the organization-level safety climate, especially in large organizations (Lingard et al., 2010). Therefore, more attention should be given to the construction safety climate at the construction-team level to reduce fatal and non-fatal injuries in the workplace.

This study aims to investigate the safety climate dimensions (SCDs) and safety climate indicators (SCIs) through literature review, expert interviews, and examination of the construction workers' perception on the safety climate from the perspective of construction teams in China. A conceptual model was proposed based on prior studies to explain the theoretical relationships between those dimensions and indicators, and a confirmatory factor analysis (CFA) was conducted to identify the SCDs and key SCIs of the safety climate of a construction team.

## 2. Literature review

### 2.1. Safety climate of construction teams

The safety climate must reflect the characteristics of the organizations (e.g., its structure, members and environment) according to its definition (Zohar, 2010), as the attitudes of a specific group of people toward safety issues are important. Teams normally have members with complementary skills and generate synergy through a coordinated effort that allows each member to maximize their strengths and minimize their weaknesses (Gangadharan and Thirumalazhagan, 2014), which is different from groups. Therefore, the safety climate of construction teams should be described as the shared perceptions among on-site construction crews concerning the safety issues in their working teams.

A construction team is described as a group of construction crews linked by a common purpose, i.e., a group of crews working together towards a specific and common goal using their positive synergy, individual and mutual accountability, and complementary skills in the construction industry (Ismail et al., 2013). In the context of China's construction industry, the construction team is one type of organization with a simple structure, usually composed of a foreman and on-site workers belonging to the same trade. The safety climate of construction teams should be different than other organizational safety climates in the facets of the structure, size, tasks and goals of the team or organization. In China, the existing survey reports indicated that construction workers were mostly from rural areas with low level of education, and most of them were over forty and had little safety training. Therefore, the safety climate of a construction team in China should also be different from other countries or regions.

### 2.2. Research on the multilevel organizational safety climate

The safety climate, as a multilevel construct, can be analyzed across multilevel organizations (Zohar, 2008). The earliest studies of safety climate are mainly from the perspective of company-level organization. For instance, Zohar (1980) conducted groundbreaking research on the safety climate in industrial organizations; Niskanen (1994a) explored the factors comprising the safety climate of the Finnish National Road Administration. A group-level model of the safety climate was developed by Zohar (2000) to supplement the existing organization-level model, explicating that the safety climate rested on the differentiation between respective sources of climate perceptions at the organizational and group levels of analysis. Subsequently, the safety climate of various industrial organizations (e.g., wood-processing industry, shipyards, the forestry industry, aircraft maintenance industry, rail industry, building construction and stevedoring) has been extensively studied (Cavazza and Serpe, 2009; Havold, 2005; Morrow et al., 2010; Neitzel et al., 2008; Varonen and Mattila, 2000). For instance, Gillen et al. (2002) measured the workplace safety climate of the construction industry in the USA. A measurement of the safety climate among construction workers was conducted by Siu et al. (2004) in Hong Kong. Huang et al. (2006) proposed a mediating model to study the relationships between the safety climate and self-reported injury in various company sectors, including manufacturing, construction, service and transportation. A dual-language English-Spanish workplace safety climate scale was developed by Jorgensen et al. (2007) for use with a mixed population of English-speaking and Spanish-speaking construction workers in the U.S. Zhou et al. (2008) conducted investigations to examine the safety climate of construction companies in China. A safety climate survey was undertaken by Lingard et al. (2010) to measure the group safety climate of three Australian construction industry organizations. Arcury et al. (2012) examined the work safety climate among Latino residential construction workers. Jafari et al. (2014) evaluated the impact of safety training on safety climate factors in two sites of a construction firm. The psychological safety climate was explored by Shen et al. (2015b) at the individual level in construction project management. Sixty-three first-line managers of two French nuclear plants were surveyed by Kouabenan et al. (2015) to measure their safety climate.

### 2.3. SCDs and SCIs for the non-construction industry

Managing the safety climate is crucial for promoting positive cognitions among construction team members and decreasing the likelihood of damages as the result of safety hazards (Liao et al., 2015). The measurement of the safety climate in a variety of organizations or groups has always been of interest to safety climate researchers (Zhou et al., 2015). Scaled dimensional measures are the most common means with which to measure the safety climate (Glendon and Stanton, 2000). Since 1980, a number of attempts have been made to devise the safety climate dimensions of many industrial companies, sectors and groups, including manufacturing, mining, construction and service, etc. (Chen and Jin, 2013; Fang et al., 2006; Flin et al., 2000; Huang et al., 2006; Niskanen, 1994a; Yule, 2003; Zhou et al., 2008; Zohar, 1980). The dimensions and indicators of the safety climate vary significantly

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